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Respectfully submitted,

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IN SITU FORMED ANIONIC CLAY-CONTAINING BODIES

5 The present invention pertains to a process for the preparation of shaped
crystalline anionic clay-containing bodies. Examples of crystalline anionic clays
include hydrotalcite, meixnerite, sjögrenite, pyroaurite, stichtite, reevesite,
eardleyite, manassite, and barbertonite. Crystalline anionic clays have several
applications in the catalyst field and as absorbents. For most commercial
10 applications crystalline anionic clays are formed into shaped bodies such as
spheres. In all applications where shaped bodies are exposed to severe
processing conditions and environments, such as oil refinery applications,
separations, purifications, and absorption processes, it is of paramount
importance that the integrity of the crystalline anionic clay-containing shaped
bodies is kept intact and attrition is prevented.

15

In the prior art, crystalline anionic clays are usually incorporated into binder or
matrix material in order to obtain attrition resistant shaped bodies. Commonly
used binder or matrix materials are alumina, and silica. Frequently used
alumina precursors are aluminium chlorohydrate, soluble aluminium salts, and
20 acid dispersed pseudo-boehmite; regular silica precursors are silica sols,
silicates, silica-alumina co-gels, and combinations thereof.

In EP-0 278 535 FCC additive or catalyst particles are described which are
prepared by embedding hydrotalcite and optionally zeolite in a silica, silica-
alumina or alumina matrix. To this end, hydrotalcite is slurried in a matrix
25 precursor dispersion containing the other catalyst components or precursors
thereof and subsequently spray-dried.

However, when crystalline anionic clay is embedded in a matrix, the amount of
active crystalline anionic clay ending up in the resulting shaped bodies tends to
30 be relatively small. There are applications in which for performance reasons it is
desired that the shaped bodies consist or mostly consist of active crystalline
anionic clay. Also, by the incorporation of crystalline anionic clay into matrix

material, physical properties of the crystalline anionic clay such as specific surface area, pore size distribution, etcetera may be detrimentally affected. Further, the distribution of the crystalline anionic clay within the matrix is difficult to control. Another disadvantage of having to use a matrix to obtain attrition resistant bodies is the fact that most commonly used matrix/binder materials have some chemical activity, which in certain applications can cause undesirable side reactions. For instance, one of the most commonly used binder materials in FCC catalysts and additives is silica or silica based material. These types of binders are not suitable for use in sulphur oxides removal additives, because they detrimentally affect the sulphur removal.

The present invention provides crystalline anionic clay-containing bodies which are attrition resistant without high amounts of binder having to be present and/or added. In fact, crystalline anionic clay-containing bodies are provided which can be binder-free. The crystalline anionic clay distribution within the crystalline anionic clay-containing bodies of the invention can easily be controlled as will be explained further in the description. Within the context of the present specification, the term "crystalline anionic clay" means a clay which has an X-ray diffraction pattern containing the specific X-ray diffraction pattern which characterises the specific type of anionic clay.

The present invention is directed to a process for the preparation of crystalline anionic clay-containing bodies from sources comprising a trivalent metal source and a divalent metal source comprising the steps of:

- a) preparing a precursor mixture containing a liquid, a divalent metal source and/or a trivalent metal source, at least one of them being insoluble in the liquid;
- b) shaping the precursor mixture to obtain shaped bodies;
- c) optionally thermally treating the shaped bodies; and

d) aging the shaped bodies to obtain crystalline anionic clay-containing bodies;

with the proviso that if no divalent or trivalent metal source is present in the precursor mixture of step a), such source is added to the shaped bodies after shaping step b) and before aging step d);

and with the further proviso that the combined use of an aluminium source as the trivalent metal source and a magnesium source as the divalent metal source is excluded.

- 10 The quintessence of the present invention is that crystalline anionic clay is formed after shaping, i.e. in situ in the shaped body. This results in very attrition resistant bodies, without the need to add a binder material. It will be clear that in order to obtain a shaped body a solid precursor must be present in the precursor mixture. Therefore, it is preferred that at least one of the metal
- 15 sources is an oxide, a hydroxide, a carbonate, or a hydroxy carbonate.

The shaped bodies can be prepared in various ways. In a preferred embodiment of the invention, a trivalent metal source and a divalent metal source are combined in a slurry to form a precursor mixture. Subsequently, said

20 precursor mixture is shaped. The resulting shaped bodies are aged, optionally after thermal treatment, in a liquid to obtain crystalline anionic clay-containing bodies.

Optionally the precursor mixture is pre-aged prior to the shaping step. This may be advantageous, because during said pre-aging step nuclei may be formed

25 which enhance the formation of the crystalline anionic clay during the aging step d).

It is also possible to prepare a precursor mixture from only one source such as an oxide, hydroxide or carbonate of a trivalent metal source or a divalent metal

30 source, shape it, and then add one or more additional other sources to the

shaped bodies in any of the subsequent process steps. During the aging step, the various sources react to give the crystalline anionic clay-containing bodies. Of course, it is also possible to use combinations of the two preparation routes described above, for instance: add the trivalent metal source and the divalent metal source to form the precursor mixture, shape to form bodies, and then age the shaped bodies in a liquid containing additional metal source to form anionic clay-containing bodies with a higher content of said additional metal on the outside of the shaped body.

- 5
- 10 Suitable trivalent metals include aluminium, gallium, indium, iron, chromium, vanadium, cobalt, manganese. Aluminium sources include aluminium alkoxide, aluminium oxides and hydroxides such as transition alumina, aluminium trihydrate (gibbsite, bayerite) and its thermally treated forms (including flash calcined alumina), alumina sols, amorphous alumina, (pseudo)boehmite,
- 15 aluminium-containing clays such as kaolin, sepiolite, and modified clays such as metakaolin, alumina salts such as aluminium nitrate, aluminium chloride, aluminium chlorohydrate, sodium aluminate, and aluminium sulphate. With the preparation method according to the invention it is also possible to use coarser grades of aluminium trihydrate such as BOC (Bauxite Ore Concentrate) or
- 20 bauxite. When clays are used as aluminium source, it may be necessary to activate the alumina in the clay by acid or base treatment, for instance acid-treated bentonite, (hydro)thermal treatment, or combinations thereof, etcetera. Acid treatment comprises treatment with nitric acid, acetic acid, phosphoric acid, sulphuric acid, hydrochloric acid, etcetera. Thermal treatment is usually
- 25 performed at temperatures ranging from 30°-1000°C, preferably 200°-800°C, for a time ranging from several minutes to 24 hours, preferably 1-10 hours. Suitable gallium, indium, iron, chromium, vanadium, cobalt, manganese sources are oxides, hydroxides, carbonates, nitrates, chlorides, chlorohydrates, and alkoxides. Also mixtures of the above-mentioned trivalent metal sources can be
- 30 used, and said different trivalent metal sources can be combined in the

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precursor mixture in any sequence. It is also possible to add a trivalent metal source after the shaping step. In that case, the precursor mixture may or may not already contain a trivalent metal source. If a trivalent metal source is added after the shaping step, it preferably is in liquid when contacted with the shaped

5 bodies. This can be done by dispersing or dissolving the trivalent metal source and adding it to the shaped bodies. Alternatively, the trivalent metal source can be added to the liquid in which the shaped bodies are aged. Also other trivalent metal sources than clay such as aluminium trihydrate may be pre-treated prior to the addition to the precursor mixture or prior to contacting it with the shaped

10 bodies. Said pre-treatment may involve treatment with acid, base treatment, thermal and/or hydrothermal treatment, all optionally in the presence of seeds or combinations thereof. It is not necessary to convert all of the trivalent metal source into crystalline anionic clay. For instance, any excess of aluminium source will be converted into alumina (usually in the form of transition alumina

15 such as γ -alumina or (crystalline) boehmite) during the aging step. These compounds improve the binding properties of the shaped bodies and may also provide different types of desirable functionalities for the bodies. For instance, alumina provides acid sites for catalytic cracking and (crystalline) boehmite also improves the nickel encapsulation capacity of the shaped bodies. The formation

20 of, for example, (crystalline) boehmite may be promoted by adding seeds, either in the precursor mixture, in the aluminium source or during aging.

Suitable divalent metal sources include magnesium, zinc, nickel, copper, iron, cobalt, manganese, calcium, barium. Suitable magnesium sources are oxides

25 or hydroxides such as MgO , $\text{Mg}(\text{OH})_2$, hydromagnesite, magnesium salts such as magnesium acetate, magnesium formate, magnesium hydroxy acetate, magnesium carbonate, magnesium hydroxy carbonate, magnesium bicarbonate, magnesium nitrate, magnesium chloride, magnesium-containing clays such as dolomite, saponite, sepiolite. Suitable zinc, nickel, copper, iron,

30 cobalt, manganese, calcium, barium sources are oxides, hydroxides,

carbonates, nitrates, chlorides. Also mixtures of the above-mentioned divalent metal sources can be used, and said different divalent metal sources can be combined in the precursor mixture in any sequence and/or in any process step after the shaping step. If a divalent metal source is added after the shaping

5 step, it is preferably in liquid when contacted with the shaped bodies. This can be done by dispersing or dissolving the divalent metal source and adding it to the shaped bodies. Alternatively, the divalent metal source can be added to the liquid in which the shaped bodies are aged. The divalent metal source may be pre-treated prior to the addition to the precursor mixture and/or prior to the

10 addition to the shaped bodies. Said pre-treatment may comprise a thermal and/or a hydrothermal treatment, an acid treatment, a base treatment, all optionally in the presence of a seed, and/or combinations thereof. It is not necessary to convert all of the divalent metal source into crystalline anionic clay. For instance, any excess of magnesium compounds will usually be converted

15 into brucite or magnesia. For the sake of clarity, this excess of magnesium compounds in the shaped particle will be referred to in the description as magnesia. The presence of magnesia in the shaped body may provide desirable functionalities to the shaped bodies such as for instance metal trap capacity. The presence of magnesia provides basic sites which render the

20 shaped body suitable for removing or neutralising strong acid streams of gases or liquids.

Shaped bodies containing anionic clay, anionic clay and magnesia or anionic clay and alumina may be used in processes involving purification and/or

25 separation or organic compounds in hydrocarbon streams, e.g. the removal of S-compounds and/or N-compounds in the gasoline and diesel fraction in FCC, and hydroprocessing. Further, said shaped bodies may be used in water treatment for removing organic and inorganic compounds for the purpose of purifying, clarifying, and separating undesirable compounds from said water

30 streams, including ion exchange processes. Also, said shaped bodies may be

used in the treatment of gaseous streams in industrial processes to remove and separate gaseous compounds such as process gaseous streams containing chlorine, hydrochloric acid, sulphur compounds (e.g. SO_x), nitrogen compounds (e.g. NO_x, ammonia) and phosphorus compounds.

5

The various process steps will be described in more detail below.

Preparation of the precursor mixture

- 10 In this step a precursor mixture is prepared from a trivalent metal source and/or a divalent metal source in a liquid. All liquids are suitable, as long as they do not detrimentally interfere with the various sources. Suitable liquids are water, ethanol, propanol, etcetera. The amount of liquid can be chosen such that a mixture with a milky substance is obtained, but also mixtures with a higher
- 15 viscosity, for instance doughs, are suitable. If more than one source is used for the precursor mixture, the sources can be added as solids, but they can also be added in liquid, provided that the combination of an aluminium and a magnesium source is excluded. The various sources can be added in any sequence. The preparation of the precursor mixture can be carried out with or
- 20 without stirring, at room temperature or elevated temperature. Optionally, the precursor mixture and/or the separate sources are homogenised by, for instance, milling. Some conversion to crystalline anionic clay may already take place upon combining the various sources. It is preferred that at least 5 wt% of the final total amount of anionic clay is already formed, but for the present
- 25 invention it is essential that conversion also takes place after the shaping step. Usually more than 25wt%, preferably more than 50 wt%, more preferably more than 75 wt% and most preferably between 80-95 wt% of the final amount of anionic clay in the shaped body is formed after the shaping step, because then shaped bodies with the highest physical strength are obtained. The divalent to

trivalent metal molar ration within the anionic clay may vary from 1:10, preferably 1 to 6, most preferably 2 to 4.

If desired, organic or inorganic acids and bases, for example for control of the pH, may be added to the precursor mixture or added to any one of the trivalent metal source and/or divalent metal source before these are added to the precursor mixture. An example of a preferred modifier is an ammonium base, because upon drying no deleterious cations remain in the anionic clay.

As mentioned above, the precursor mixture may be pre-aged prior to the shaping step. Said pre-aging temperature may range from 30° to 500°C and may be conducted under atmospheric or increased pressure such as autogeneous pressure at temperatures above 100°C. The aging time can vary from 1 minute to several days, for instance 7 days. By adding specific anions to the precursor mixture and/or any of the trivalent metal and/or divalent metal source the interlayer-charge balancing anions present may be controlled. Usually, the pH must be controlled to introduce the desired form of the interlayer charge balancing anion, many charge balancing anions are pH-dependent. Examples of suitable anions are carbonates, bicarbonates, nitrates, chlorides, sulphates, bisulphates, vanadates, tungstates, borates, phosphates, pillaring anions such as $V_2O_7^{4-}$, $HV_2O_{12}^{4-}$, $V_3O_9^{3-}$, $V_{10}O_{28}^{6-}$, $Mo_7O_{24}^{6-}$, $PW_{12}O_{40}^{3-}$, $B(OH)_4^-$, $[B_3O_3(OH)_4]^-$, $[B_3O_3(OH)_5]^{2-}$, $B_4O_5(OH)_4^{2-}$, HBO_4^{2-} , $HGaO_3^{2-}$, CrO_4^{2-} , Keggin-ions, formates, acetate, and mixtures thereof. It is believed that the presence of some of these anions such as carbonate, bicarbonate, sulphate and or nitrate influences the forming of side products such as brucite. Further, the addition of ammonium hydroxide promotes meixnerite formation, whereas the addition of ammonium carbonate promotes hydrotalcite formation. It goes without saying, that in those cases wherein a specific anion is preferred in the anionic clay, the reaction conditions in the further preparation steps must be adapted so as to avoid exchange of the anion by other less preferred anions.

Shaping

Suitable shaping methods include spray-drying, pelletising, extrusion (optionally combined with kneading), beading, or any other conventional shaping method used in the catalyst and absorbent fields or combinations thereof. The amount of liquid present in the precursor mixture used for shaping should be adapted to the specific shaping step to be conducted. It might be advisable to partially remove the liquid used in the precursor mixture and/or add additional or other liquid, and/or change the pH of the precursor mixture to make the precursor mixture gellable and thus suitable for shaping. Various additives commonly used in the various shaping methods such as extrusion additives may be added to the precursor mixture used for shaping.

Thermal treatment

After shaping the shaped bodies may optionally be submitted to a thermal treatment. Such a treatment increases the physical strength of the particles. The thermal treatment can be conducted in an oxygen-containing atmosphere, a hydrogen-containing atmosphere, in an inert atmosphere or in steam at temperatures varying from 30° to 900°C for a time ranging from a few minutes to 24 hours. As in, for instance, spray-drying a thermal treatment is inherently involved, a further thermal treatment may not be necessary.

Aging

In this step, the shaped bodies are immersed in a protic liquid or protic gaseous medium. During the aging step crystallisation to crystalline anionic clay takes place. Suitable protic aging liquids or gaseous media are those liquids and gaseous media in which the shaped bodies do not dissolve, such as water, ethanol, methanol, propanol, steam, gaseous water, gaseous ethanol, etcetera.

Increasing the temperature of the liquid and/or the pressure can reduce the aging time. The aging can also be conducted under autogeneous conditions. The aging temperature may range from 30° to 500°C. The aging time can vary from 1 minute to several days, for instance 7 days. For some purposes it is advantageous to conduct several aging steps, optionally with intermediate drying steps, optionally followed by calcination steps. For instance, an aging step with a temperature below 100°C may be followed by a hydrothermal aging step at a temperature above 100°C and autogeneous pressure, or vice versa. As will be described below in further detail, additives can be added before, after or during any aging step. By adding specific anions to the aging medium at controlled pH, the interlayer-charge balancing anions present may be controlled. Examples of suitable anions are carbonates, bicarbonates, nitrates, chlorides, sulphates, bisulfates, vanadates, tungstates, borates, phosphates, pillaring anions such as $V_2O_7^{4-}$, $HV_2O_{12}^{4-}$, $V_3O_9^{3-}$, $V_{10}O_{28}^{6-}$, $Mo_7O_{24}^{6-}$, $PW_{12}O_{40}^{3-}$, $B(OH)_4^-$, $[B_3O_3(OH)_4]^-$, $[B_3O_3(OH)_5]^{2-}$, $B_4O_5(OH)_4^{2-}$, HBO_4^{2-} , $HGaO_3^{2-}$, CrO_4^{2-} , Keggin-ions, formates, acetate, and mixtures thereof. It is also believed that the presence of some of these anions such as carbonate, bicarbonate, sulphate, and/or nitrate influence the forming of side products such as brucite. Further, the addition of ammonium hydroxide promotes meixnerite-like clay formation, whereas the addition of ammonium carbonate promotes hydrotalcite-like clay formation.

For some applications it is desirable to have additives present in and/or on the shaped bodies according to the invention, both metal compounds and non-metal compounds, comprising rare earth metals (especially Ce and La), Si, P, B, Bi, Group VI metals, Group VIII metals, noble metals such as Pt and Pd, alkaline earth metals (for instance Ca and Ba) and/or transition metals (for example Mn, Fe, Ti, V, W, Zr, Cu, Ni, Zn, Mo, Sn). Said additives can be added separately or in mixtures in any of the preparation steps of the invention. For instance, they can easily be deposited on the shaped bodies before, during, or

after aging, or else they can be added to the precursor mixture and/or any of the trivalent metal or divalent metal sources. Suitable sources of metal compounds and non-metal compounds are oxides, halides or any other salt, such as chlorides, nitrates, phosphates, etcetera. As mentioned above, the additives
5 may be added in any of the preparation steps. This can be especially advantageous for controlling the distribution of the additives in the shaped bodies. It is even possible to calcine the shaped bodies, rehydrate them and add additional additives. It is further possible to reduce, hydrogenate or sulphurize the metals after and/or during introduction.

10 With the help of additives the shaped bodies may be provided with desired functionalities, or the desired functionality may be increased by the addition of additives. The suitability of anionic clay-containing shaped bodies for the removal of SO_x and/or NO_x compounds in FCC may be improved by the addition of Ce and/or V. The presence of V and Zn improves the suitability for
15 removal of S-compounds in the gasoline and diesel fraction of FCC. The presence of Zn and Mn improves metal trapping. As described above, these functionalities may also be built in by using an excess of trivalent metal source and/or divalent metal source. A combination of these measures increases the effect.

20

The crystalline anionic clay-containing bodies may also be prepared to contain conventional catalyst components such as matrix or filler materials (e.g. clay such as kaolin, phosphated kaolin, titanium oxide, zirconia, alumina, silica, silica-alumina, bentonite etcetera), molecular sieve material (e.g. zeolite Y, USY
25 zeolite, ion-exchanged zeolite, ZSM-5, beta-zeolite, ST-5 etcetera). Said conventional catalyst components may be added prior to the shaping step. Because the anionic clay is formed in situ, the resulting body will have a homogeneous dispersion of anionic clay and catalyst components. With the method according to the invention, multiple-functional bodies can be prepared
30 which can be used as a catalyst or as a catalyst additive.

The process according to the invention may be conducted batch-wise or in a continuous mode, optionally in a continuous multi-step operation. The process may also be conducted partly batch-wise and partly continuous.

5

If desired, the crystalline anionic clay-containing shaped bodies prepared by the process according to the invention may be subjected to ion exchange, in which the interlayer charge-balancing anions of the clay are replaced with other anions. Said other anions are the ones commonly present in anionic clays and include pillaring anions such as $V_2O_7^{4-}$, $HV_2O_{12}^{4-}$, $V_3O_9^{3-}$, $V_{10}O_{28}^{6-}$, $Mo_7O_{24}^{6-}$, $PW_{12}O_{40}^{3-}$, $B(OH)_4^-$, $[B_3O_3(OH)_4]^-$, $[B_3O_3(OH)_5]^{2-}$, $B_4O_5(OH)_4^{2-}$, HBO_4^{2-} , $HGaO_3^{2-}$, CrO_4^{2-} , Keggin-ions. Examples of suitable pillaring anions are given in US 4,774,212, which is included by reference for this purpose. Said ion exchange can be conducted as soon as the crystalline anionic clay has been formed.

15

The present invention is further directed to crystalline anionic clay-containing shaped bodies obtainable by the process according to the invention. As mentioned above, the shaped bodies appear to have high mechanical strength and attrition resistance, comparable with that of clay-containing bodies prepared by dispersing clay into a matrix or binder material and then shaping the clay-containing composition, yet without matrix or binder material having to be added to the crystalline anionic clay. This means that with the process according to the invention, crystalline anionic clay-containing shaped bodies can be prepared containing more than 25 wt%, preferably more than 50 wt%, more preferably more than 70 wt% or even more preferably more than 90 wt% crystalline anionic clay. Although binder material may be present in the shaped crystalline anionic clay containing bodies according to the invention, for instance as a result of an excess aluminium source present in the precursor mixture, any binder that is present in the shaped bodies according to the invention will be present as a discontinuous phase, as is depicted schematically in Figure 1. This

is in contrast to clay-containing bodies prepared in the conventional way, i.e. by embedding clay into a matrix or binder material, where the binder material in the bodies is present in a continuous phase, as is schematically depicted in Figure 2. It is of course also possible to incorporate the crystalline anionic clay-containing shaped bodies into a matrix. In that case, composite particles are obtained which comprise crystalline anionic clay-containing shaped bodies with, optionally, binder material in a discontinuous phase, embedded in a binder material, as is schematically depicted in figure 3.--

Figure 1: Schematic view of a shaped body according to the invention
Figure 2: Schematic view of a shaped body according to the prior art
Figure 3: Schematic view of a composite particle comprising shaped bodies according to the invention

In Figure 1 a schematic view is given of a shaped crystalline anionic clay-containing body (1) according to the present invention which comprises crystalline anionic clay (2) and binder material (3) in a discontinuous phase.

In Figure 2 a schematic view is given of a shaped crystalline anionic clay-containing body (1) according to the prior art which comprises crystalline anionic clay (2) and binder material (3) in a continuous phase.

In Figure 3 a schematic view is given of a composite particle comprising crystalline anionic clay-containing shaped bodies (1) which comprise crystalline anionic clay (2) and binder material (3) in a discontinuous phase which are embedded in binder material (3') which is in a continuous phase.

During or prior to use in catalytic applications, anionic clays are often thermally treated to obtain so-called solid solutions or spinels. The present invention is also directed to shaped bodies and composite particles containing thermally treated anionic clay.

The invention is further illustrated by examples which are not to be considered limitative.

EXAMPLES

5

Example 1

Flash calcined gibbsite, Cp grade, was slurried in water that contained zinc carbonate. The slurry was homogenized with shear mixing and pelletized to
10 shaped bodies. The shaped bodies were and calcined at 250°C for 4 hours. The calcined shaped bodies were slurried in water and aged at 65°C for 18 hours. The pH of the slurry was adjusted to 9.5 with ammonium hydroxide. XRD analysis indicated the presence of Zn-Al hydrotalcite in the shaped bodies.

15

Example 2

Flash calcined gibbsite, Cp grade, was slurried in water that contained iron (II) nitrate. The slurry was homogenized with shear mixing and pelletized to shaped bodies. The shaped bodies were calcined at 250°C for 4 hours. The calcined
20 shaped bodies were slurried in water and aged at 65°C for 18 hours. The pH of the slurry was adjusted to 9.5 with ammonium hydroxide. XRD analysis indicated the presence of Fe-Al hydrotalcite in the shaped bodies.

Example 3

25

Gallium nitrate was added to an aqueous slurry containing magnesium oxide. The slurry was homogenized with shear mixing and formed to shaped bodies by spray drying. The shaped bodies were calcined at 250°C for 4 hours. The calcined shaped bodies were slurried in water and aged at 65°C for 18 hours.

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The pH of the slurry was adjusted to 9.5 with ammonium hydroxid. XRD analysis indicated the presence of Mg-Ga hydrotalcite in the shaped bodies.

Example 4

5

Aluminium trihydrate (46.5) was slurried in 466 g de-ionised water containing 389.6 g $\text{Fe}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. The total amount of slurry was 976 g and had a solids content of 13 wt%. The resulting slurry was pelletized. The pellets were aged hydrothermally at 175°C for 2 hours. The product was dried overnight at 110°C.

10 XRD showed the formation of Fe-Al anionic clay.



5. Process according to any one of the claims 1-4 wherein the trivalent metal source is present in the precursor mixture and a divalent metal source is added after the shaping step b) and wherein the trivalent metal source is selected from the group consisting of oxides, hydroxides, carbonates, hydroxy carbonates and combinations thereof.
5
6. Process according to any one of the claims 1-5 wherein a divalent metal source is present in the precursor mixture and a trivalent metal source is added after the shaping step b) and wherein the divalent metal source is selected from the group consisting of oxides, hydroxides, carbonates, hydroxy carbonates and combinations thereof.
10
7. Process according to any one of the claims 1-6 wherein the trivalent metal source is selected from aluminium trihydrate, its thermally treated form or boehmite.
15
8. Process according to any one of the claims 1-7 wherein the trivalent metal source comprises kaolin, phosphated kaolin, bentonite, metakaolin and/or bauxite.
20
9. Process according to any one of the claims 1-6 wherein the divalent metal source comprises magnesium oxide.
- 25 10. Process according to any one of the preceding claims wherein more than one aging step is conducted, optionally with intermediate drying steps, optionally followed by calcining.
- 30 11. Process according to any one of the preceding claims wherein additives are added in step a).

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CLAIMS

1. Process for the preparation of crystalline anionic clay-containing bodies from sources comprising a trivalent metal source and a divalent metal source comprising the steps of:
- 5 a) preparing a precursor mixture containing a liquid, a divalent metal source and/or a trivalent metal source, at least one of them being insoluble in the liquid;
- b) shaping the precursor mixture to obtain shaped bodies;
- 10 c) optionally thermally treating the shaped bodies; and
- d) aging the shaped bodies to obtain crystalline anionic clay-containing bodies;
- with the proviso that if no divalent or trivalent metal source is present in the precursor mixture of step a), such source is added to the shaped bodies
- 15 after shaping step b) and before aging step d);
- and with the further proviso that the combined use of an aluminium source as the trivalent metal source and a magnesium source as the divalent metal source is excluded.
- 20 2. Process according to claim 1, wherein the precursor mixture contains a divalent metal source and a trivalent metal source.
3. Process according to claim 1 or 2 wherein the precursor mixture is pre-aged prior to shaping step b).
- 25 4. Process according to claim 2 or 3 wherein in step a) a trivalent metal source and a magnesium source are combined to obtain a precursor mixture.

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12. Process according to any one of the preceding claims wherein additives are added after the shaping step b).
- 5 13. Process according to any one of the preceding claims wherein additives are added in any one of the aging steps.
14. Crystalline anionic clay-containing shaped body obtainable by any one of the processes of claims 1-12.
- 10 15. Crystalline anionic clay-containing body wherein any binding material present in the body is present in a discontinuous phase.
- 15 16. Crystalline anionic clay-containing body according to claim 13 or 14 wherein alumina is present.
17. Crystalline anionic clay-containing body according to any one of claims 13-15 wherein magnesia is present.
- 20 18. Shaped body containing thermally treated anionic clay obtained by thermally treating a crystalline anionic clay-containing body according to any one of claims 13-17.
- 25 19. Composite particle comprising a crystalline anionic clay-containing body according to claim 17 which is embedded in binder material.
20. Composite particle comprising a shaped body containing thermally treated anionic clay according to claim 18.

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21. Process for the purification and/or separation of organic compounds in hydrocarbon streams wherein a crystalline anionic clay-containing body is used according to any one of claims 13-17.
- 5 22. Process for the removal of organic and inorganic compounds for the purpose of purifying, clarifying or separating undesirable compounds from water wherein a crystalline anionic clay-containing body according to any one of claims 13-17 is used.
- 10 23. Process for the removal and separation of gaseous compounds from gaseous streams wherein a crystalline anionic clay-containing body according to any one of claims 13-17 is used.
- 15 24. Anionic clay-containing composition obtainable by step a) of the process according to any one of the claims 2-4 or 7-11.

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ABSTRACT

The present invention is directed to a process for the preparation of crystalline anionic clay-containing bodies from sources comprising a trivalent metal source and a divalent metal source comprising the steps of:

- a) preparing a precursor mixture containing a liquid, a divalent metal source and/or a trivalent metal source, at least one of them being insoluble in the liquid;
- e) shaping the precursor mixture to obtain shaped bodies;
- 10 f) optionally thermally treating the shaped bodies; and
- g) aging the shaped bodies to obtain crystalline anionic clay-containing bodies;

with the proviso that if no divalent or trivalent metal source is present in the precursor mixture of step a), such source is added to the shaped bodies after shaping step b) and before aging step d);

15 and with the further proviso that the combined use of an aluminium source as the trivalent metal source and a magnesium source as the divalent metal source is excluded.

20 The quintessence of the present invention is that the anionic clay is formed after shaping, i.e., in situ in the shaped body. This results in very attrition resistant bodies, without the need to add a binder material.



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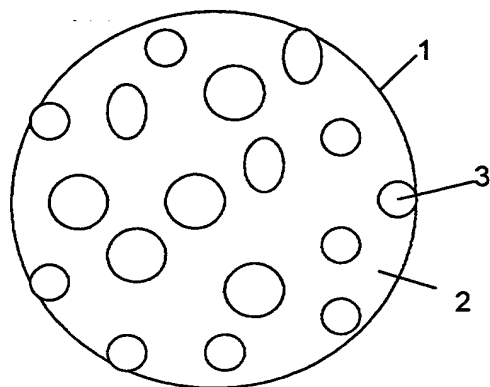


Figure 1. Shaped body according to the invention

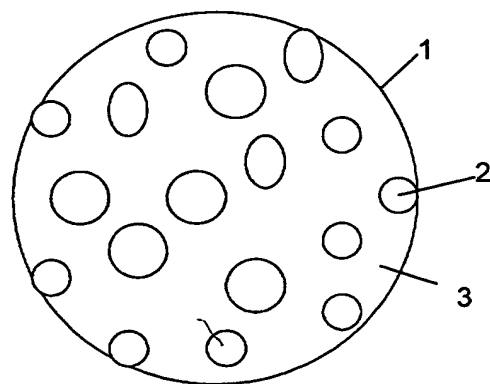


Figure 2. Shaped body according to the prior art

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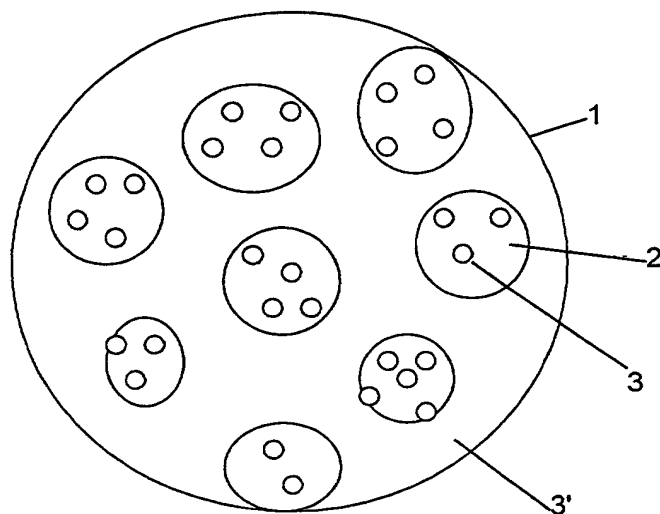


Figure 3. Composite particle comprising shaped bodies according to the invention